UNITED STATES DISTRICT COURT
DISTRICT OF MINNESOTA

REGENTS OF THE UNIVERSITY OF MINNESOTA, Plaintiff, v. AT&T MOBIILITY LLC, Defendant ERICSSON, INC., AND NOKIA OF AMERICA CORP., Intervenor- Defendants	Civil No. 14-4666 (JRT/TNL)
REGENTS OF THE UNIVERSITY OF MINNESOTA, Plaintiff, v. SPRINT SPECTRUM L.P., et al., Defendants, ERICSSON, INC., NOKIA OF AMERICA CORP., AND NOKIA SOLUTIONS AND NETWORKS US LLC, Intervenor- Defendants	Civil No. 14-4669 (JRT/TNL)
REGENTS OF THE UNIVERSITY OF MINNESOTA, Plaintiff, v. T-MOBILE USA, INC., Defendant, ERICSSON, INC., NOKIA OF AMERICA CORP., AND NOKIA SOLUTIONS AND NETWORKS US LLC, Intervenor- Defendants	Civil No. 14-4671 (JRT/TNL)

REGENTS OF THE UNIVERSITY OF MINNESOTA, Plaintiff, v. CELLCO PARTNERSHIP D/B/A VERIZON WIRELESS Defendant, ERICSSON, INC., AND NOKIA OF AMERICA CORP., Intervenor- Defendants	Civil No. 14-4672 (JRT/TNL)

MEMORANDUM OPINION AND ORDER CONSTRUING CLAIM TERMS

Aamir Abdulqader Kazi, **FISH & RICHARDSON, PC,** 1180 Peachtree Street Northeast, Atlanta, GA 30309; Conrad A Gosen, **FISH & RICHARDSON, PC**, 60 South Sixth Street, Suite 3200, Minneapolis, MN 55402; Frank E. Scherkenbach, Lawrence K. Kolodney, and Whitney Reichel, **FISH & RICHARDSON, PC,** One Marina Park Drive, Boston, MA 02210; John-Paul Robert Fryckman, **FISH & RICHARDSON, PC**, 12860 El Camino Real, Suite 400, San Diego, CA 92130; Katherine D. Prescott, **FISH & RICHARDSON, PC**, 500 Arguello Street, Suite 500, Redwood City, CA 94603; Brian J. Slovut and Carrie Ryan Gallia, **OFFICE OF GENERAL COUNSEL FOR THE UNIVERSITY OF MINNESOTA**, 200 Oak Street Southeast, Suite 360, Minneapolis, MN 55455; William R. Woodford, **AVANTECH LAW, LLC**, 80 South Eighth Street, Suite 900, Minneapolis, MN 55402 for plaintiff;

Barbara P. Berens and Carrie L. Zochert, **BERENS & MILLER, PA,** 80 South Eighth Street, Suite 3720, Minneapolis, MN 55402; Benjamin Hershkowitz, Josh A. Krevitt, and Laura Corbin, **GIBSON, DUNN & CRUTCHER LLP**, 200 Park Avenue, New York, NY 10166; Neema Jalali, **GIBSON, DUNN & CRUTCHER LLP**, 555 Mission Street, Suite 3000, San Francisco, CA 94105, for defendant AT&T Mobility LLC;

David E. Finkelson and George Brian Davis, **MCGUIRE WOODS LLP**, Gateway Plaza, 800 East Canal Street, Richmond VA 23219; Jason W. Cook, **MCGUIRE WOODS LLP,** 2000 McKinney Avenue, Suite 1400, Dallas, TX 75201; John A.

Cotter, **LARKIN HOFFMAN DALY & LINDGREN, LTD**, 8300 Norman Center Drive, Suite 1000, Minneapolis, MN 55437; Karen D. McDaniel, **TAFT STETTINIUS & HOLLISTER LLP**, 2200 IDS Center, 80 South Eighth Street, Minneapolis, MN 55402, for defendants Sprint Solutions, Inc, Sprint Spectrum, LP, T-Mobile USA, Inc., ;

Frank C. Cimino, Jr., Jeffri A. Kaminski, and Leslie A. Lee, **VENABLE LLP**, 600 Massachusetts Avenue Northwest, Washington, DC 20001; 55437; Karen D. McDaniel, **TAFT STETTINIUS & HOLLISTER LLP**, 2200 IDS Center, 80 South Eighth Street, Minneapolis, MN 55402, for defendant Cellco Partnership d/b/a Verizon Wireless

Casey Lynne Shoemaker, Jonathan Nathanial Powers, Nicolas M. Mathews, and Warren H. Kipschitz, I, **MCKOOL SMITH, PC**, 300 Crescent Court, Suite 1500, Dallas, TX 75201; Kevin Hess, **MCKOOL SMITH, PC**, 303 Colorado Street, Suite 2100, Austin TX, 78701; Karen D. McDaniel and Michael M. Lafeber, **TAFT STETTINIUS & HOLLISTER LLP**, 2200 IDS Center, 80 South Eighth Street, Minneapolis, MN 55402; Theodore Stevenson, III, **ALSTON & BIRD LLP**, 2200 Ross Avenue, Suite 2300, Dallas, TX 75201, for defendant-intervenor Ericsson, Inc.

Brianne Straka, David Aaron Nelson, John Poulos, Marc Lawrence, Kaplan, Nathaniel Andrew Hamstra, and Stephen Andrew Swedlow, **QUENN EMANUEL URQUHART & SULLIVAN, LLP**, 191 North Wacker Drive, Suite 2700, Chicago, IL 60606; Jonathan A. Strauss and Sonia L. Miller-Van Oort, **SAPIENTIA LAW GROUP PLLC**, 120 South Sixth Street, Suite 100, Minneapolis, MN 55402; Karen D. McDaniel, **TAFT STETTINIUS & HOLLISTER LLP**, 2200 IDS Center, 80 South Eighth Street, Minneapolis, MN 55402, for defendant-intervenors Nokia of America Corp. and Nokia Solutions and Networks US LLC;

Plaintiff, Regents of the University of Minnesota (the "University") filed this lawsuit against AT&T, Sprint, T-Mobile, and Verizon, alleging infringement of five wireless communication patents—7,251,768 ("'768 Patent"), RE45,230 ("'230 Patent"), 8,588,317 ("'317 Patent"), 8,718,185 ("'185 Patent'), and 8,744,309 ("'309 Patent'). Both Ericsson

and Nokia intervened into the lawsuit.[1] The case was stayed in 2017 while the parties conducted an Inter Partes Review on the asserted patents. After the Patent Trial and Appeal Board denied the review, the Court lifted the stay and the parties proceeded with claim construction. The parties dispute the construction of fourteen groups of related terms. For the reasons explained below, the Court sets forth its construction of the disputed terms.

BACKGROUND

A. Overview of Patented Technology

The patent technology was developed by University of Minnesota professor Georgios Giannakis and his team in the early 2000s. (*See, e.g.*, Decl. Jonathan Wells, Ex. A ("'768 Patent"), Nov. 3, 2021, Docket No. 35.) The patented technology is intended to improve the transmission of data over cellular networks and the communication between a transmitter, such as a cell tower, and a receiver, such as a cell phone. A transmitter sends information to a receiver via a radio signal which is able to transmit large amounts of data quickly. That radio signal must be fast and reliable, and the patent technology discusses certain techniques that improve the speed and reliability of those radio signals.

Digital data is represented by 1s and 0s, also known as "bits". (Wells Decl. ¶ 18.) Before the data or bits can be transmitted on a radio signal, it must be converted into waveform. (*Id.* ¶¶ 18-20.) In order to create a waveform, the bits must be converted into

[1] Defendants and Intervenor-Defendants are referred to herein collectively as "Defendants."

"symbols" where each symbol corresponds to a unique pattern of bits. (*Id.*) When there are two bits or more, the data can be arranged into combinations of those bits and then translated into symbols, this collection of symbols is known as a "constellation." (*Id.*) That information is then transmitted over a radio signal to a receiver that converts the constellation back into its symbols and finally the stream of bits of data. (*Id.* ¶ 20.)

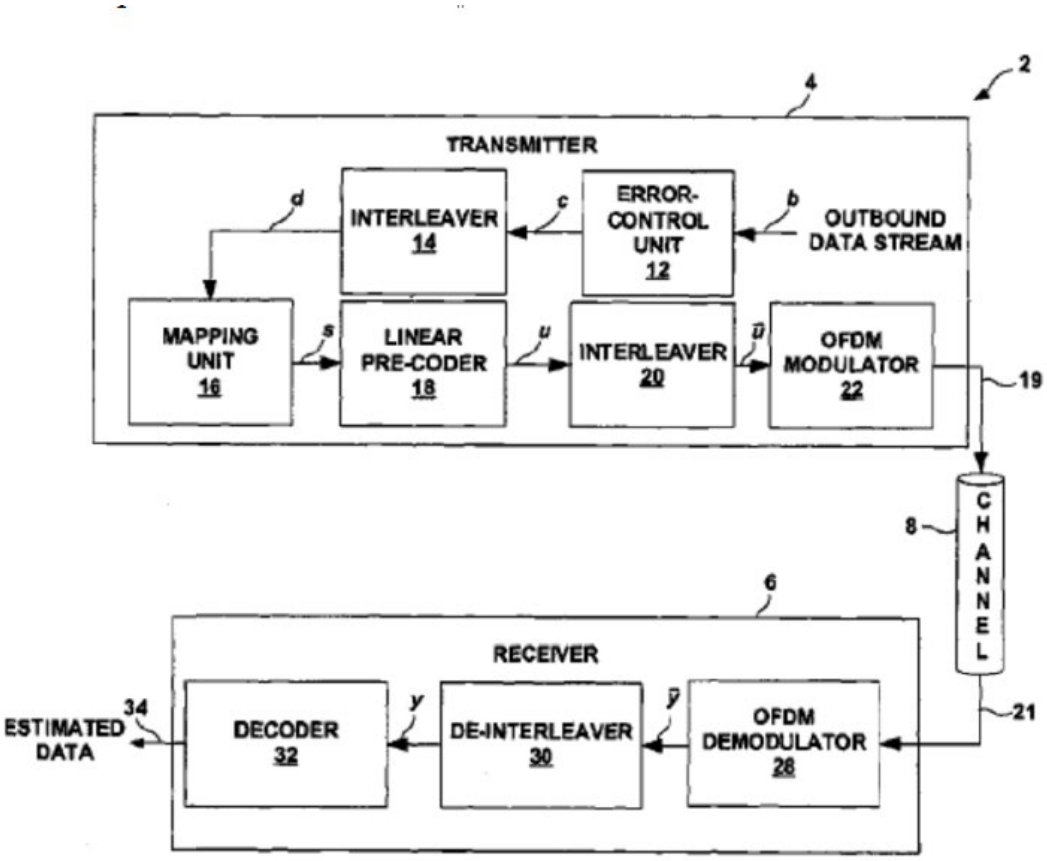
Ideally, the data that is transmitted via the radio signal would be received by the receiver in the identical form it left the transmitter. But in the real world, that normally is not the case as the signal can often be distorted or lost due to interference or other factors. (*Id.* ¶ 21.) To guard against interference, communication systems will add redundant information so that if a portion of the transmission is lost, the redundant information fills it in. (*Id.*) Adding the redundant information is known as "coding" or "encoding." (*Id.*) The patents discuss two different types of encoding. The first is known as "error control coding" which occurs prior to the bits of information being transformed into their constellation of symbols. ('768 Patent, at 1:50–55, 4:28–32; Figure 1.) The second type is called "precoding" which looks at the constellation of symbols and modifies the symbol values. (*Id.*)

In older technology, digital data was transmitted over one single channel, meaning a transmitter would send a single, sequential stream of information to a receiver. (Wells Decl. ¶ 22.) Newer technology allows data to be transmitted to a receiver over parallel channels. (*Id.*) Relevant to the patents here is what is known as multi-carrier transmission

systems which allow a single transmitter to transmit to a receiver a sequence of data at the same time over parallel channels operating at different frequencies. (*Id.*) The channels are also known as "subcarriers." (*Id.*) The patents at issue in this case discuss different types of multi-carrier transmission systems such as the "Orthogonal Frequency Division Multiplexing" ("OFDM") and "Multiple-Input Multiple-Output" ("MIMO"). (*Id.*) In a MIMO system, multiple antennas are used on one transmitter to transmit data sequences on parallel frequencies. (*Id.*) Precoding and multiple transmission channels are frequently used in combination.

B. '768 and '230 Patents

The '768 and '230 Patents involve digital coding techniques that are intended to improve the efficiency and accuracy of the transmission of data. ('768 Patent; Wells Decl., Ex. B ("'230 Patent").) The '768 and '230 Patents involve an ideal system which incorporates these digital coding techniques, this system is pictured below:



('768 Patent, Figure 1.)

The system begins with processes in the transmitter. In the transmitter, the bits of data first go through an error control unit which codes the data to create a stream of coded bits. (Wells Decl. ¶ 31; '768 Patent at 4:22–25.) That stream of coded bits is then interleaved, meaning the order of those bits is rearranged. (Wells Decl. ¶ 31; '768 Patent at 4:33–35.) Next, the mapping unit takes the stream of coded and interleaved bits and converts it into a constellation of symbols. (Wells Decl. ¶ 30; '768 Patent at 4:35–44.) That constellation of symbols is then linearly precoded meaning that the constellation of symbols is combined or modified in a way to create precoded symbols. (Wells Decl. ¶ 30;

'768 Patent at 4:44–49.) The precoded symbols are interleaved again. (Wells Decl. ¶ 30; '768 Patent at 4:50–67.) Finally, the precoded symbols are sent through the OFDM modulator which transforms the symbols into waveform and sends them out to the receiver. (*Id.*) Once received by the receiver, the symbols are demodulated, de-interleaved, and decoded. ('768 Patent, Figure 1.) The '768 and '230 Patents not only discuss this system in general, but they also provide for particular methods to be utilized within certain portions of the system and which are intended to help with the speed and reliability of the wireless communication.

C. '317 Patent Family

The '317 Patent Family, which include the '317, '185, and '309 Patents, focuses on technology intended to train the receivers to correct for non-ideal conditions in wireless channels. (Wells Decl. ¶ 32.) Under the '317 Patent Family, in order to train the receivers, the transmitter will send out a predefined value at a predefined time, known as a "training symbol." (Wells Decl. ¶ 32; Wells Decl., Ex. C ("'317 Patent") at 2:16–36, 4:22–45.) Because the receiver already knows both the value and timing of the training symbol, when it receives the transmission, it can compare and adjust for any non-ideal conditions. (Wells Decl. ¶ 32.)

One of these training symbols is known as a "null subcarrier" whose transmission includes no value. (Wells Decl. ¶ 33; '317 Patent at 2:27–32.) The '317 Patent Family details a technique for inserting a null subcarrier into blocks of symbols. (*Id.*) The '317

Patent Family patents refer to a hopping code, which determines where in an information block to place a null subcarrier. (Wells Decl. ¶ 33; '317 Patent at 2:30–32, 4:24–31.) The '317 Patent Family also discuss techniques for inserting not only a null subcarrier but other training symbols into a block for transmission over a multi-channel transmission system.

D. Procedural History

In 2014, the University filed a Complaint in the above captioned matters against Defendants AT&T, Sprint, T-Mobile, and Verizon asserting claims of direct and indirect infringement and willful blindness. (*See, e.g.*, Am. Compl., Jan. 30, 2015, Case No. 14-4666, Docket No. 25.) All four of the Defendants moved to dismiss the Regent's Amended Complaint and the Court denied those motions as to the Regent's claim for direct infringement, induced infringement, and contributory infringement. (Mem. Opinion Order Mot. Dismiss, Sept. 29, 2015, Docket No. 45.) The Court dismissed the Regent's willful blindness claims. (*Id.*) Ericsson and Nokia America Corp. moved to intervene in the lawsuits and the Court granted both motions. (*See, e.g.*, Order, Mar. 30, 2016, Case No. 14-4666, Docket No. 131; Order, Mar. 31, 2016, Case No. 14-4666, Docket No. 136.) In 2017, the Court granted a motion for a limited stay pending a decision on inter partes review from the United States Patent and Trademark Office ("USPTO"). (*See, e.g.*, Order, May 19, 2017, Case No. 14-4666, Docket No. 237.) That stay was lifted in 2020 and the parties then filed their *Markman* briefs in November 2021. (University's Markman Brief,

Nov. 3, 2021, Case No. 14-4666, Docket No. 304; Defendants' and Defendants-Intervenors' Markman Brief, Nov. 3, 2021, Case No. 14-4666, Docket No. 306.)

DISCUSSION

I. CLAIM CONSTRUCTION PRINCIPLES

Claim construction is a question of law for the Court. *Allen Eng'g Corp. v. Bartell Indus., Inc.*, 299 F.3d 1336, 1344 (Fed. Cir. 2002). "The purpose of claim construction is to determine the meaning and scope of the patent claims that the plaintiff alleges have been infringed." *Every Penny Counts, Inc. v. Am. Express Co.*, 563 F.3d 1378, 1381 (Fed. Cir. 2009). Claim terms are given their ordinary and customary meaning as understood by one of ordinary skill in the art at the time of the invention. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005). To ascertain this meaning and define the scope of the invention, courts look to the words of the claims themselves, the specification, and the prosecution history of the patent. *Id.* at 1314; *see also Masco Corp. v. United States*, 303 F.3d 1316, 1324 (Fed. Cir. 2002); *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582–83 (Fed. Cir. 1996).

"[T]he claims themselves provide substantial guidance as to the meaning of particular claim terms." *Phillips*, 415 F.3d at 1314. The context of the surrounding words of the claim term may be instructive on the ordinary and customary meaning of the term. *Id.* Courts also consider "[o]ther claims of the patent in question, both asserted and unasserted," to determine the ordinary and customary meaning of a claim term. *Id.*

"Because claim terms are normally used consistently throughout the patent, the usage of a term in one claim can often illuminate the meaning of the same term in other claims." *Id.* Differences in the claim language can also be a useful guide, and "different words or phrases used in separate claims are presumed to indicate that the claims have different meanings and scope." *Seachange Int'l, Inc. v. C-COR, Inc.*, 413 F.3d 1361, 1368 (Fed. Cir. 2005) (internal citations omitted).

Claims do not stand alone but are part of "a fully integrated written instrument," which includes the specification. *See Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 978 (Fed Cir. 1995). The specification is the single best guide to the meaning of a disputed term, and "claims must be read in view of the specification, of which they are a part." *Phillips*, 415 F.3d at 1315 (internal citations omitted). Courts, however, will not import a limitation from the specification into the claims. *Id.* at 1320. The Federal Circuit has "repeatedly warned against confining the claims to . . . embodiments" described in the specification. *Id.* at 1323.

The patent's prosecution history should also be considered as intrinsic evidence. *Id.* at 1317. The prosecution history "consists of the complete record of the proceedings before the PTO and includes the prior art cited during the examination of the patent." *Id.* The prosecution history, however, "often lacks the clarity of the specification and thus is less useful for claim construction purposes." *Id.* But the prosecution history may still "inform the meaning of the claim language by demonstrating how the inventor

understood the invention and whether the inventor limited the invention in the course of prosecution, making the claim scope narrower than it would otherwise be." *Id.* (citing *Vitronics*, 90 F.3d at 1582–83).

Although the intrinsic evidence mentioned above is of primary importance in construing a patent's claim terms, the Court may also rely on extrinsic evidence. Extrinsic evidence consists of "all evidence external to the patent and prosecution history, including expert inventor testimony, dictionaries, and learned treatises." *Markman*, 52 F.3d at 980. Extrinsic evidence is less significant than intrinsic evidence in construing claim terms and cannot establish a meaning of the claim term that is at odds with the intrinsic evidence. *Phillips*, 415 F.3d at 1317–18.

There are two exceptions to the rule that a claim term must be given its ordinary and plain meaning: (1) when a patentee sets out their own definition of the term, or (2) when the patentee disavows the full scope of the claim term either in the specification or during prosecution. *Thorner v. Sony Comput. Entm't Am. LLC,* 669 F.3d 1362, 1365 (Fed. Cir. 2012). Thus, "[i]t is not enough for a patentee to simply disclose a single embodiment or use a word in the same manner in all embodiments[.]" *Id.* at 1366. In making a disclaimer or disavowal, there must be a "clear and unmistakable" expression of the limitation. *Id.* at 1366–67.

II. ANALYSIS

A. Linear Precoding Terms ('768 Patent, Claims 1, 13, and 21)

1. "A precoder that applies"; "a precoder that linearly precodes"; "linearly precoding"

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
A precoder that applies a linear transformation that transforms a block of input symbols into a block of output symbols in which each output symbol is a linear combination, or weighted sum, of input symbols.	A precoder that applies a linear transformation to combine two or more of the constellation symbols with each other to produce precoded symbols, wherein the linear transformation has the following properties: 1) For any constellation symbols a and b, f(a + b) = f(a) + f(b) 2) For any scalar k, f(k*a) = k*f(a)	A precoder that applies a linear transformation to combine constellation symbols with each other to produce precoded symbols in which each output symbol is a linear combination.

The disputes over the construction of "precoder" in Claims 1, 13, and 21, of the '768 Patent are two-fold. The parties first dispute whether the definition should require combining two or more constellation symbols.[2] The second dispute concerns whether the definition should include the terms "linear combination, or weighted sum" as proposed by the University.[3]

a. Two or More Constellation Symbols

[2] The University, in their reply brief, concedes that the term "constellation symbols" should be used in the definition of precoder rather than input/output symbols. (University's Reply, at 2, Dec. 3, 2021, Docket No. 312.)

[3] Defendants proposed construction includes their proposed construction for the definition of "linear transformation." The Court addresses this claim construction *infra* Part II.A.2. As the term linear transformation is used in the Court's construction of "precoder," the Court sees no need for redundancy—defining linear transformation in both the construction of precoder and within its own construction. As such, the use of the term "linear transformation" in the Court's construction of "precoder" is sufficient here.

Defendants have not pointed to any intrinsic or extrinsic evidence which requires that the precoding function combine two or more constellation symbols. Furthermore, precoding can be done on one constellation symbol as constellation symbols include both real and imaginary components that can be combined in a linear transformation. Thus, the Court will adopt the term "constellation symbol" but will not construe the linear precoding terms to require the combination of two or more constellation symbols.

b. Linear Combination or Weighted Sum

The University's proposed construction states that each output of the precoder should be a "linear combination, or weighted sum." The term "linear combination" is included in the '768 and '230 Patents by reference. The '768 and '230 Patents reference the five provisional patent applications, which includes Provisional Application No. 60/374,953 (the "935 provisional"). (*See, e.g.*, '768 Patent at 1:7–12; Wells Decl., Ex. G.) The '935 provisional states that "linear precoding" is a term of art which means "sending linear combinations of symbols." (Wells Decl., Ex. G, at 6–7.) Defendants do not appear to contest the use of the term "linear combination" to describe "linear precoding." As the term is incorporated into the patents by reference, the Court finds it appropriate to include "linear combination" in the claim construction of "linear precoder."

The same cannot be said about the University's proposed inclusion of the term "weighted sum." The University argues that "weighted sum" should be included in this claim construction because the ordinary meaning of "linear combination" includes the

term "weighted sum." (University's Markman Brief, at 22; Wells Decl., ¶ 40 (citing to a dictionary definition of "linear combination" that includes "weighted sum").) Though the Court may take extrinsic evidence into account, intrinsic evidence is of "primary importance." *Phillips*, 415 F.3d at 1317–18. As Defendants aptly point out, a weighted sum need not be a linear combination. For example, the weighted sum of squares would not be linear. Weighted sum is a broader term than is meant to be captured by the term "linear precoder" or even "linear combination."

Furthermore, the Court sees no reason to include redundant language since, as the University asserts, weighted sum is contained within the definition of linear combination. The University argues that including the redundant language will make the concept clearer to the jury. But in fact, weighted sum is another term of art, and the Court cannot understand how inclusion of a redundant and equally foreign term to a lay person would add any clarity. Rather, it would likely lead to more confusion. *Cordis Corp. v. Boston Sci. Corp.*, 561 F.3d 1319, 1337 (Fed. Cir. 2009) (noting that the purpose of claim construction is to minimize the "risk of confusion to the jury[.]"). Additionally, in construing a claim term, the Court must look to the meaning "the term would have to a person of ordinary skill in the art" and not what a jury member may understand the term to mean. [.]" *Power-One, Inc. v. Artesyn Techs., Inc.*, 599 F.3d 1343, 1348 (Fed. Cir. 2010). A person skilled in the art would not need the additional term "weighted sum" to understand what

is meant by a "linear combination." Thus, the Court will include the term "linear combination" but not "weighted sum."

In sum, the Court will construe the terms "a precoder that applies;" "a precoder that linearly precodes;" and "linearly precoding" as "A precoder that applies a linear transformation to combine constellation symbols with each other to produce precoded symbols in which each output symbol is a linear combination."

2. "Linear Transformation"

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
A mathematical operation on vectors f(x), which has the property that for any vectors a and b that are valid arguments to f, f(a + b) = f(a) + f(b), and for any scalar k f(k*a) = k*f(a). The linear transformation does not include the operation of using a spreading sequence of chips to spread each information-bearing symbol over a set of data symbols.	A precoder that applies a linear transformation to combine two or more of the constellation symbols with each other to produce precoded symbols, wherein the linear transformation has the following properties: 1) For any constellation symbols a and b, f(a + b) = f(a) + f(b) 2) For any scalar k, f(k*a) = k*f(a)	A mathematical operation on vectors f(x), which has the property that for any vectors a and b that are valid arguments to f, f(a + b) = f(a) + f(b), and for any scalar k f(k*a) = k*f(a). The linear transformation does not include the operation of using a spreading sequence of chips to spread each information-bearing symbol over a set of data symbols.

The University claims that it made a "clear and unmistakable" disclaimer that the definition of "linear transformation" did not include a specific type of linear transformation that involves the use of a spreading sequence of chips. Patent claim terms

must be given their ordinary and plain meaning except when a patentee disavows the full scope of the claim term in either the specification or the patent prosecution. *Thorner*, 669 F.3d at 1365. Such a disclaimer must be a "clear and unmistakable" expression of the limitation. *Id.* at 1366–67.

During the prosecution of the '768 patent, the patent examiner preliminarily rejected certain claims as being previously anticipated by an earlier patent known as the Kaiser Patent. (Wells Decl., Ex. M at UMN0000232.) The inventors, in response, distinguished the Kaiser Patent, making the following statement:

> In **contrast** with the wireless communication device of claim 1 [of the '768 Patent], Kaiser describes an OFDM transmission path having a spreading and sequence imposition unit . . . . The operation of spreading a single information bearing symbol over a set . . . of data symbols **is different from linearly precoding** a complex field of each original symbol **(i.e., applying a linear transformation)** . . . . There is no evidence of record to indicate that applying a spreading sequence linearly transforms the complex field of the information-bearing symbols at all.

(*Id.* (emphasis added).)

The University asserts that because the inventors distinguished the Kaiser Patent from the '768 Patent by establishing that the '768 Patent does not use a spreading sequence of chips in the linear transformation, a spreading sequence of chips has been disclaimed from the '768 Patents definition of linear transformation.

Defendants disagree, pointing to the '768 patent preapplication specification material which included the use of a spreading sequence. While the Defendants are correct that the '768 preapplication specification material included a spreading sequence,

this is not sufficient to undercut the disclaimer for two reasons. First, the '768 preapplication specification uses a spreading sequence but not a spreading sequence of chips, which is the subject of the disclaimer. (Decl. Daniel van der Weide, ¶ 78, Nov. 3, 2021, Docket No. 308.) Second, a disclaimed subject matter will supersede the specifications. *Uship Intell. Prop., LLC v. United States*, 714 F.3d 1311, 1316 (Fed. Cir. 2013).

The Court finds the University's statement is sufficiently clear and unmistakable such that it rises to the level of a disclaimer. In response to the examiner identifying the Kaiser patent as potentially anticipating the '768 patent invention, the inventors identified the spreading sequence used in the Kaiser patent and stated their invention was in "contrast" to the spreading sequence. The inventors then went on to describe how a spreading sequence of chips is different from the linear precoding used in the '768 Patent. These statements demonstrate to the Court that the linear precoding considered in the '768 patent did not use a spreading sequence of chips. This statement from prosecution of the '768 Patent constitutes a disclaimer, such that the definition of "linear transformation" does not include the operation of using a spreading sequence of chips. Thus, the Court construes the term "linear transformation" in the '768 Patent as follows:

> A mathematical operation on vectors f(x), which has the property that for any vectors a and b that are valid arguments to f, f(a + b) = f(a) + f(b), and for any scalar k f(k*a) = k*f(a). The linear transformation does not include the operation of using a spreading sequence of chips to spread each information-bearing symbol over a set of data symbols."

B. Linear Transformation Terms ('230 Patent Claims 1, 16, 49, 64 and 68)

1. "Applies/Applying a linear transformation"

University's Proposed Construction	Defendants' Proposed Construction[4]	Court's Construction
transforms/transforming blocks of symbols from the stream of information bearing symbols, using a linear transformation to produce symbols that are linear combinations, or weighted sums, of information bearing symbols.	Applies/applying a time invariant linear transformation to the stream of information bearing symbols by combining two or more of the information bearing symbols with each other to produce precoded symbols wherein the linear transformation has the following properties: 1) For any constellation symbols a and b, f(a + b) = f(a) + f(b) 2 2) For any scalar k, f(k*a) = k*f(a)	Applies/applying a time invariant linear transformation to the stream of information bearing symbols by combining the information bearing symbols with each other to produce precoded symbols that are linear combinations of information bearing symbols.

This claim construction involves two issues resolved above. First, the Court will not adopt the University's proposed use of the phrase "weighted sum." Second, the Court will not adopt the Defendants' narrower proposed construction that two or more symbols must be combined because one symbol could potentially be combined with itself. Thus, the main dispute between the parties over the construction of this phrase in the '230

[4] Defendants proposed construction includes their proposed construction for the definition of "linear transformation." The Court addresses this claim construction *infra* Part II.B.2. As the term "linear transformation" is used in the Court's construction of "applying a linear transformation" the Court sees no need for redundancy— and will cabin its discussion in this section to the issues raised with the construction of the term "applying/applies a linear transformation."

Patent is Defendants' proposed limitation that the linear transformation be "time invariant."

In a linear transformation, the precoding equation may include an element of time (i.e. time variant) or it may not (i.e. time invariant). The parties agree that the ordinary meaning of linear transformation includes time variant precoding equations as well as time invariant precoding equations. Defendants allege that the University disclaimed time varying linear transformations in the '230 Patent specification. Therefore, they argue, since time variance has been disclaimed, the claim should be construed to reflect this disclaimer. *Thorner*, 669 F.3d at 1365.

The disclaimer must be "clear and unmistakable." Defendants point to the following statement in the '230 Patent specification to support their assertion that time varying linear transformations have been disclaimed:

> The [linear transformation] considered here **does not depend** on the OFDM symbol index i. Time-varying encoder may be useful for certain purposes, (e.g., power loading), **but they will not be pursued here**. Hence, from now on, we will drop our OFDM symbol i for brevity.

(Wells Decl., Ex. B ("'230 Patent") at 5:25–30.) The symbol "i" represents time. The '230 patent went on to recite the equation for a linear transformation equation over 80 times and did not include a variable for time in any of those 80 references.

This statement constitutes a clear and unmistakable disclaimer of time varying linear transformations. "Where the specification **makes clear** that the invention does not include a particular feature, that feature is deemed to be outside the reach of the claims

of the patent, even though the language of the claims, read without reference to the specification, might be considered broad enough to encompass the feature in question." *SciMed Life Sys. v. Adv. Cardiovascular Sys.*, 242 F.3d 1337, 1341 (Fed. Cir. 2001) (emphasis added). The University's strained reading of this statement—that the inventors simply note their preferred embodiment, but are not disclaiming time-varying encoders—is unpersuasive. The '230 Patent specification clearly and unmistakably states that the linear transformation "does not depend" on an element of time, and that time-varying encoders "will not be pursued here." Further, nowhere in the '230 Patent specification do the inventors use the element of time. The Court finds that the '230 Patent makes clear that time-varying linear transformations are not included in the invention and these types of linear transformations fall outside the '230 Patent. Thus, the Court will adopt Defendants' proposed limitation and construe the claim term "applies/applying linear transformations" as follows: "Applies/applying a time invariant linear transformation to the stream of information bearing symbols by combining the information bearing symbols with each other to produce precoded symbols that are linear combinations of information bearing symbols."

2. "Linear Transformation"

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
a mathematical operation on vectors f(x), which has the property that for any vectors a and b that are valid arguments to f, f(a + b) = f(a) + f(b), and for any scalar k f(k*a) = k*f(a). The linear transformation does not include the operation of using a spreading sequence of chips to spread each information-bearing symbol over a set of data symbols.	Applies/applying a time invariant linear transformation to the stream of information bearing symbols by combining two or more of the information bearing symbols with each other to produce precoded symbols wherein the linear transformation has the following properties: 1) For any constellation symbols a and b, f(a + b) = f(a) + f(b) 2) For any scalar k, f(k*a) = k*f(a)	a mathematical operation on vectors f(x), which has the property that for any vectors a and b that are valid arguments to f, f(a + b) = f(a) + f(b), and for any scalar k f(k*a) = k*f(a). The linear transformation does not include the operation of using a spreading sequence of chips to spread each information-bearing symbol over a set of data symbols.

The parties propose the same constructions for the claim "linear transformation" in the '230 Patent as they did for the same claim term in the '768 Patent. The parties only dispute here is whether the linear transformation in the '230 patent includes a spreading sequence of chips or if, like the '768 patent, this type of linear transformation has been specifically disclaimed.

"When multiple patents derive from the same initial application, the prosecution history regarding a claim limitation in any patent that has issued applies with equal force to subsequently issued patents that contain the same claim limitation." *Elkay Mfg. Co. v. Ebco Mfg. Co.*, 192 F.3d 973, 980 (Fed. Cir. 1999). The prosecution history of a related patent can be relevant if it addressed the same common limitation. *Advanced*

Cardiovascular Sys., Inc. v. Medtronic, Inc., 265 F.3d 1294, 1305 (Fed. Cir. 2001). The '230 and '786 Patents derive out of the same five provisional applications, have identical applicants, inventors, and assignees, and concern the same subject matter. The prosecution history of the '768 Patent disclaiming a spreading sequence of chips is therefore relevant to the '230 Patent.

Abbott Laboratories v. Dey., L.P., 287 F.3d 1097 (Fed. Cir. 2002) and *In re Berg*, 140 F.3d 1428 (Fed. Cir. 1998), cited by Defendants, are inapposite. In *Abbott Labs.*, the patents at issue had "no formal relationship" and the subsequent patent related to additional and independent research done by one of the three inventors of the prior patents. 287 F.3d 1097 at 1105. The same is not true here. The '768 and '230 patents derive from the same provisional patents, the '230 patent has nearly identical inventors, and the '230 patent does not relate to additional and independent research done by only one of the inventors. In *In re Berg*, the Federal Circuit Court held two patent applications were independent and patentably distinct because they were not a continuation, continuation-in-part, or divisional. 140 F.3d at 1435. But notably, the Federal Circuit Court was concerned with the fact that the PTO was not informed of any relationship between the patents and importantly, the issue before the court was not related to a disclaimer limiting a claim term. *Id.* There is no such concern here. Further, the Court does not read *In re Berg*, as requiring that a patent must be a continuation, continuation-in-part, or divisional of the related patent in order for a disclaimer to apply to both, but

rather the Federal Circuit Court used these terms as a helpful guide in determining whether patents are related. Additionally, Defendants have failed to point the Court to any Federal Circuit case law that asserts this is the hard and fast rule.

As the patents are relevant to one another, contain a significant amount of similarities, and have a formal relationship in that they derive from the same provisional applications, the disclaimer regarding a spreading sequence of chips in the '768 Patent prosecution history applies to the '230 Patent. As such, the Court will adopt the University's proposed construction of the claim term "linear transformation" in the '230 Patent.

C. Interleaver Terms ('768 Patent Claims 1, 8, 13, & 21; '230 Patent Claims 1, 13, 16, and 49)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
An electronic circuit or computer-implemented algorithm that takes an ordered set of precoded symbols and reorders them.	An electronic circuit or computer-implemented algorithm that takes the precoded symbols and reorders them to separate adjacent symbols.	An electronic circuit or computer-implemented algorithm that takes the ordered set of precoded symbols and reorders them.

The parties dispute the construction of the term "interleave." This dispute has two facets. First, the parties contest whether interleaving requires that all adjacent symbols be separated or whether it simply requires reordering the symbols in some way. Second,

the parties disagree on whether the term should be construed to allow interleaving on groups of symbols versus solely individual symbols.

First, Defendants assert that the proper construction of "interleave" requires that the symbols be reordered so all previously adjacent symbols are separated. Defendants support this construction by pointing to the definition of interleave in Newton's Telecommunication Dictionary—"[i]n the interleaving process, code symbols are reordered before transmission in such a manner that any two successive code symbols are separated[.]" Newton's Telecommunications Dictionary, at 413 (19th ed. 2003). Defendants claim that this construction makes sense in the context of the inventions at issue here. They argue that by allowing adjacent symbols to remain together, the invention would be inoperable because its effectiveness in reducing burst errors would be significantly reduced. Defendants explain that if adjacent symbols are allowed to remain together, an interleaver could simply reverse the symbols so that the symbols are technically interleaved but whole chunks of data could still be lost in short term interference.

But what Defendants' proposed construction omits, is the use of a random interleaver, which is explicitly included in the preferred embodiments of both the '768 and '230 patents. A random interleaver, while randomizing the symbols, does not guarantee that all previously adjacent symbols will be separated. Under Defendants' proposed construction, the University's preferred embodiments would be left out. A

claim construction that excludes preferred embodiments is "rarely, if ever, correct" and should only be construed to exclude that preferred embodiment if there is probative evidence. *Vitronics Corp.*, 90 F.3d at 1583; *GE Lighting Solutions, LLC v. Agilight Inc.*, 750 F.3d 1304, 1311 (Fed. Cir. 2014).

The only probative evidence supplied by Defendants is the definition of "interleave" from a dictionary. But Defendants' definition of "interleave" is by no means universal. In fact, the University points to two other dictionaries whose definitions of "interleave" do not require that adjacent symbols be separated. (Suppl. Decl. of Jonathan Wells, ¶ 22, Dec. 3, 2021, Docket No. 313.) The Court must do its best to construe the claim to include preferred embodiments and Defendants have pointed to no probative evidence that would require the Court to hold otherwise. As such, the Court declines to adopt Defendants' proposed construction of "interleave" and finds that the term does not require adjacent symbols be separated.

Second, the University asserts that "interleave" should be construed so that it includes the interleaving on groups of symbols, rather than solely on individual symbols. Though the University claims that construing interleave to allow interleaving on individual symbols/bits impermissibly limits the ordinary meaning of the term, in truth, the University's construction seeks to expand the term's reach beyond what was intended in the patent. The term "interleave" on its face, does not include the interleaving of groups of symbols. Rather interleave is used as a verb and requires a subject to which the

interleaving is taking place. As the '768 and '230 Patents make clear, that subject is individual symbols/bits, not groups of symbols. (*See, e.g.*, '768 Patent at 5:1–3 ("interleaver 14 may be viewed as a bit interleaver, while interleaver 20 may be viewed as a symbol interleaver."); '230 Patent at 20:57–58 ("an interleaver that interleaves the encoded symbols to produce interleaved symbols").) As the patents discuss interleaving symbols/bits and do not discuss interleaving groups of symbols, the Court will decline to adopt the University's expansion of the claim term.

As such, the Court will construe the term "interleave" as follows: "An electronic circuit or computer-implemented algorithm that takes the ordered set of precoded symbols and reorders them."

D. Multiple Matrices Terms ('230 Patent)

1. "[wherein the] linear transformation is based on multiple matrices" ('230 Patent Claims 30, 33, 40, 43, 64 & 68)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
The linear transformation can be described as multiplication by a matrix that is the product of at least two other matrices	Indefinite	The linear transformation can be described as multiplication by a matrix that is the product of at least two other matrices

The Defendants assert that this claim term is indefinite because, as they argue, the use of the term "based on" fails to provide any clear boundaries as to what else may be included in the linear transformation equations outside of the multiple matrices. "A patent is invalid for indefiniteness if its claims, read in light of the specification delineating

the patent, and the prosecution history, fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention. *Nautilus, Inc. v. Biosig Instruments, Inc.*, 572 U.S. 898, 901 (2014). Thus, the "definiteness requirement . . . mandates clarity, while recognizing that absolute precision is unattainable." *Id.* at 910.

The Court cannot agree that this claim term is indefinite. One skilled in the art would understand that the linear transformation used in the '230 Patent must include two or more matrices, this is in fact, quite obvious. The term "based on" is not so indefinite when read in light of the specification and prosecution history of the patent to require the Court hold otherwise. Thus, the Court will adopt the University's construction of this term.

2. "wherein the linear transformation is based on a Fourier transform" ('230 Patent Claim 77)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
The linear transformation can be expressed as a mathematical operation that includes a Fourier transform	Indefinite	The linear transformation can be expressed as a mathematical operation that includes a Fourier transform

Defendants raise similar concerns with this claim term, arguing that the use of the term "based on" renders the term indefinite as it fails to inform someone skilled in the art what the boundaries of the linear transformation equation can be. Again, a patent is invalid for indefiniteness if, when read in light of the specification, it fails to inform those

skilled in the art about the scope of the invention with reasonable certainty. *Nautilus*, 572 U.S. at 901.

Though true that the claim term does not fully inform one skilled in the art about the scope of the invention, the specification provides the equations used in the '230 Patent that are based on a Fourier transform. Upon reading the specification, one skilled in the art would understand, with reasonable certainty, the types of equations, and deviations of those equations, permissible under the '230 Patent. Furthermore, the phrase "based on a Fourier transform" is not highly subjective. *See Interval Licensing LLC v. AOL, Inc.*, 766 F.3d 1364, 1371 (Fed. Cir. 2014) (finding the term "unobtrusive manner" highly subjective because the phrase depended on the preferences of each individual person). The claim term requires that the linear transformation equation include a Fourier transform, one skilled in the art has no discretion in the decision to include the Fourier transform. The term, then, is not highly subjective, in that it requires uniformity to a certain degree regardless of the individual performing the equation. The term is not indefinite or highly subjective and, therefore, the Court will adopt the University's construction of this term.

3. "wherein the first matrix is based on a fast Fourier transform (FFT) matrix, and wherein the second matrix is based on a diagonal matrix"('230 Patent Claims 30, 64, & 68) / "wherein the first matrix is a matrix of size N_txN_t . . . wherein the second matrix is a diagonal matrix" ('230 Patent Claims 33 & 43)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
Wherein the first matrix can be expressed as a mathematical operation that includes a Fast Fourier transform (FFT) matrix, and wherein the second matrix can be expressed as a mathematical operation that includes a diagonal matrix	The term "based on" is indefinite. Should the court find this term to not be indefinite, the linear transformation must be represented in the following order: [FFT Matrix] * [Diagonal matrix]	The linear transformation must be represented in the following order: [FFT Matrix] * [Diagonal matrix]
The first matrix is a matrix with N_t rows and N_t columns, where N_t is the number of transmit antennas in the transmitter. The second matrix is a diagonal matrix.	The term "based on" in the prior limitation of this claim is indefinite. Should the court find this term to not be indefinite, the linear transformation must be represented in the following order: [first matrix of size N_t rows by N_t columns, wherein each entry of the first matrix is based on a power of $e^{j2\pi/Nt}$, each entry of a column of the first matrix being equal to one,] * [second matrix that is a diagonal matrix of size N_txN_t having diagonal entries that are based respectively on different powers of $e^{j2\pi/P}$ including the zeroth power, wherein P is a positive integer][5]	The linear transformation must be represented in the following order: [first matrix of size N_t rows by N_t columns, wherein each entry of the first matrix is based on a power of $e^{j2\pi/Nt}$, each entry of a column of the first matrix being equal to one,] * [second matrix that is a diagonal matrix of size N_txN_t having diagonal entries that are based respectively on different powers of $e^{j2\pi/P}$ including the zeroth power, wherein P is a positive integer]

Defendants again take issue with the use of term "based on." As the Court has already stated, this term is not indefinite. The main dispute here, then, is the ordering of

[5] While this appears to be lengthy, the Court need only concern itself with the order of the matrices because the language comes directly from the claim itself. ('230 Patent at 25:45–52.) The University raised no issue with this particular language.

the specific types of matrices—whether, as Defendants argue, the use of the terms "first" and "second" within the claims require a specific ordering of the matrices for multiplication purposes. This is significant because multiplication is not commutative, the order of the matrices matters in the output of the equation.

The University claims that the use of labels "first" and "second" simply identifies the claim elements but does not imply a serial or temporal limitation. The University cites both *3M Innovative Properties Co. v. Avery Dennison Corp.* and *Gillette Co. v. Energizer Holdings, Inc.* to support this assertion. 350 F.3d 1365, 1371 (Fed. Cir. 2003); 405 F.3d 1367, 1373 (Fed. Cir. 2005). But both of these cases are distinguishable. In *3M*, the use of the terms "first" and "second" were employed to distinguish between repeated instances of an element or limitation. 350 F.3d at 1371. So too with the use of those phrases in *Gillette*, where the patent used the numerical terms to distinguish between different blades on a razor. 405 F.3d at 1373. But here, there is no such need to use "first" and "second" to distinguish between repeated elements or limitations because the matrices carry their own distinguishing names. One skilled in the art knows that an FFT matrix is distinct from a diagonal matrix. The Court sees no other reason to use "first" and "second" other than to indicate the order of the matrices in the equation. This conclusion is supported by the intrinsic record which orders the matrices accordingly. (*See, e.g.* '935 provisional at 47, 59.)

As such, the Court rejects the Defendants' assertion that the claim terms are indefinite and will adopt Defendants' proposed claim construction and construe the claim terms as such.

E. Phase Rotate Term—"A diagonal matrix to phase rotate each entry of a symbol vector" ('230 Patent Claims 30, 64, 68)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
A diagonal matrix that applies a set of phase offsets to the entries of a symbol vector, such as $diag(1, a, \ldots a^{N_t-1})$ to modify the phase of at least some of those symbols **Modified Proposal:** A diagonal matrix that applies different phase rotation values to each of the entries of a symbol vector.	Indefinite	A diagonal matrix that applies different phase rotation values to each of the entries of a symbol vector.

Phase rotation is a mathematical operation used in the linear transformation described in the '230 Patent. The '230 Patent uses the following diagonal matrix equation for phase rotation: $diag(1, a, \ldots a^{N_t-1})$. Defendants assert that the claim term "a diagonal matrix to phase rotate **each entry** of a symbol vector" is indefinite because the diagonal matrix equation used in the patent specification does not rotate the first symbol because that symbol is multiplied by a 1, as shown above. Defendants claim that

construing the claim term to allow the first symbol to be phase rotated by "1" would impermissibly expand the definition of phase rotation under the '230 patent to allow for the use of a diagonal matrix of all "1s." Defendants assert this would render the patent indefinite because such a diagonal matrix of all "1s" would not change the phase rotation of any of the symbols. Further, since, they argue, that at least the first symbol is not phase rotated because it remains the same, the '230 Patent claim that each entry of a symbol vector be rotated is internally inconsistent and indefinite.

To eliminate Defendants' concern that a diagonal matrix of all "1s" could satisfy the claim term, the University presents a modified construction that would be consistent with the claims and description of the invention—that the phase rotation used should create a diversity of phase rotations. The first symbol would be phase rotated by "1," and all subsequent symbols would be phase rotated by different values to result in each symbol being phase rotated differently.

The plain language of the claim requires that each symbol be phase rotated. Contrary to Defendants' assertion, the Court sees the use of "1" in a diagonal matrix as a phase rotation. Though the symbol's phase rotation does not change, to argue that phase rotating the first symbol by "1" does not constitute a phase rotation operation would be akin to saying that the multiplication of any number by "1" is not a multiplication operation. But this is not true, as it is common knowledge that 2x1 is a multiplication operation, regardless of the fact that 2x1=2. Use of a diagonal matrix that multiplies the

first symbol by "1" still constitutes a phase rotation. And this is supported by the specification which is consistent throughout that the use of "1" in the equation is considered a phase rotation. It is also consistent with the claim term requirement that each entry of a symbol vector be rotated because phase rotating by "1" does constitute a phase rotation. "The construction that stays true to the claim and most naturally aligns with the patent's description of the invention will be, in the end, the correct construction." *Philips v. AWH*, 415 F.3d 1303, 1316 (Fed. Cir. 2005). The University's modified proposed construction should assuage any concerns the Defendants have about the expansion of the claim term to allow diagonal matrices consisting only of "1s." As such, the Court will adopt the University's modified proposed construction.

F. Unitary Matrix Term—"applying a unitary matrix" ('230 Patent Claims 3, 46 and 56)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
Performing a mathematical operation that, when expressed in matrix form includes multiplication with at least a unitary matrix **Modified Construction:** Performing a mathematical operation that, when expressed in its matrix form and simplified to eliminate matrix terms that do not affect the mathematical result, includes	Performing a mathematical operation that, when expressed in its matrix form, is multiplication by a unitary matrix	Performing a mathematical operation that, when expressed in its matrix form and simplified to eliminate matrix terms that do not affect the mathematical result, includes multiplication with at least a unitary matrix.

multiplication with at least a unitary matrix.		

The main dispute between the parties on this claim term is whether the claim term requires the use of a mathematical operation that includes a unitary matrix or is limited to an operation that solely multiplies by a unitary matrix and performs no other mathematical operations.

There are three claims at issue here: claims 3, 46, and 56. Claims 46 and 56, when discussing application of a unitary matrix, also use the phrase "comprise." "[T]he term 'comprising' raises a presumption that the list of elements is nonexclusive[.]" *Dippin' Dots, Inc. v. Mosey,* 476 F.3d 1337, 1343 (Fed. Cir. 2007). Based on this presumption and because there is no other limiting language in these claims, claims 46 and 56 are not limited to an operation solely involving a unitary matrix. Thus, the operations discussed in claims 46 and 56 must include a unitary matrix, but are not confined to an operation that multiples by a unitary matrix.

Claim 3, however, requires a bit more analysis. Claim 3 does not use the term "comprise." And though claim 3 depends on claim 1 which does have the word "comprise," use of that word in claim 1 relates to the elements of the wireless communication device described in claim 1, not the operation the encoder uses in its linear transformation. But this does not mean the term "applying a unitary matrix" in claim 3 is limited as Defendants propose. In fact, the Court reads the claim term as rather

open-ended and absent any limiting language, the plain and ordinary meaning of the term "applying" does not require that the application be limited to only that operation. Furthermore, contrary to Defendants' assertion, the use of the word "comprise" in claims 46 and 56 do not inform anything regarding the absence of the term in claim 3 because the claims relate to different portions of the technology involved.

Defendants seem to be concerned with an open-ended construction because it could allow for any mathematical operation to fall within the confines of the claim so long as that operation was multiplied by the unitary matrix UU* which does not change the outcome of an equation at all. The University's modified proposed instruction alleviates this concern. As such, the Court will adopt the University's modified proposed construction for the term "applying a unitary matrix" in claims 3, 46 and 56 of the '230 Patent.

G. Linear Combination Term—"Subcarriers carry different linear combinations of the information symbols" ('230 Patent Claims 2 & 17)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
The different subcarriers carry different weighted sums of the stream of information symbols transformed by the second encoder.	Subcarriers carry different linear combinations of the stream of information symbols transformed by the second encoder.	Subcarriers carry different linear combinations of the stream of information symbols transformed by the second encoder.

The University proposes adding the term "weighted sum" to the construction of this term. The Court has already discussed this issue *supra* Part II.A.1.b. The University

has presented no additional arguments or evidence that would support including the term "weighted sum" here in the '230 Patent. As the Court sees no reason to add redundant language that does not appear in the claim term, the Court will adopt the Defendants' proposed construction.

H. Subcarrier Term ('230 Patent, Claims 2 & 17; All asserted claims '317, '185, and '309 Patents)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
In a multi-carrier waveform, one of a number of frequencies within a larger frequency band.	In a MIMO multi-carrier waveform, one of a number of carrier frequencies within a larger frequency band.	'230 Patent: In a multi-carrier waveform, one of a number of frequencies within a larger frequency band. '317 Patent Family: In a MIMO multi-carrier waveform, one of a number of carrier frequencies within a larger frequency band.

This dispute is whether a "subcarrier" as used in both the '317 Patent Family and the '230 Patent must be limited to subcarriers on a MIMO multi-carrier waveform. A subcarrier is a term of art that refers to one carrier frequency within a band of frequencies. In a MIMO transmission system, the transmitter uses multiple antennas to transmit data to a receiver. While the parties have requested the same claim construction for the term "subcarrier" in both the '230 Patent and the '317 Patent Family, the Court

finds, as discussed below, that different constructions for the term in its corresponding patent is appropriate.

The '317 Patent Family clearly use MIMO systems. In fact, every one of the patents in the family have the title "Estimating Frequency-Offsets and Multi-Antenna Channels in MIMO OFDM Systems." (*See, e.g.*, '317 Patent at 2[6].) Furthermore, the embodiments in the '317 Patent Family employ a MIMO system. (*See, e.g.*, '309 Patent at 4:16–21 ("In general, the invention describes techniques for performing carrier frequency offset (CFO) and channel estimation of . . . OFDM . . . transmissions output by transmitters over . . . MIMO frequency-selective fading channel.").) "A patent's statement of the described invention's purpose informs the proper construction of claim terms[.]" *Kaken Pharm. Co. v. Iancu*, 952 F.3d 1346, 1352 (Fed. Cir. 2020). And though the inventors did not set out their own definition of the term "subcarrier" in the '317 Patent Family, by limiting the invention only to MIMO systems, construing the claim term to be limited to MIMO systems is consistent with the context of the rest of the patent and the specification. *Phillips*, 415 F.3d at 1314. The Court will adopt the Defendants' proposed construction of "subcarrier" in construing that term in the '317 Patent Family.

The '230 Patent mandates a different conclusion. The '230 Patent mentions MIMO once in the Certificate of Correction. ('230 Patent at 36.) Absent limiting language, the Court cannot construe "subcarrier" to be limited to only a MIMO system in the '230

[6] This citation is to the ECF page number.

Patent. Thus, the Court will adopt the University's proposed construction in construing the term "subcarrier" as the term appears in the '230 Patent.

In sum, the term "subcarrier" is construed in the '317 Patent Family as follows: In a MIMO multi-carrier waveform, one of a number of carrier frequencies within a larger frequency band. And the term is construed in the '230 Patent as follows: In a multi-carrier waveform, one of a number of frequencies within a larger frequency band.

I. '317 Patent Family

1. "Null Subcarrier" (all asserted claims '317, '185, and '309 Patents)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
A subcarrier on which no value is intended to be transmitted during a specific time period	A subcarrier on which no value is intended to be transmitted during a specific time period, used to estimate carrier frequency offset	A subcarrier on which no value is intended to be transmitted during a specific time period

The parties dispute whether the claim construction of the term "null subcarrier" should limit the use of null subcarriers in the '317 Patent Family inventions to the estimation of carrier frequency offset ("CFO")[7] or if the term should be construed to allow the use of null subcarriers for other functions. A null subcarrier transmits no value, or a zero value, in the transmission so that if a block of data appears in a position assigned to

[7] CFO is the difference between the frequency assigned to the communication when it leaves the transmitter and the frequency of the signal actually received. It allows a receiver to correct for distortions and interference in the radio signal.

the null subcarrier, the receiver is able to analyze the shift in frequency and estimate the CFO.

The Court declines to adopt the Defendants' proposed limitation to this claim term. First, the ordinary and plain meaning of "null subcarrier" does not limit it to CFO estimation, a point on which both parties agree. The only way to limit the term then, is by the patent limiting the term itself or the patentee specifically disavowing the full scope. *Thorner*, 669 F.3d at 1365. There is a definition of "null subcarrier" in the '317 Patent, but this definition only reinforces the Court's conclusion that the term "null subcarrier" is not limited to CFO. ('317 Patent at 5:39–40 ("[e]ach subcarrier corresponding to a zero symbol is referred to as a null subcarrier.").) The patent does not require null subcarriers to estimate CFO. This construction does not render the patent inoperable because under this construction the null subcarrier can be used for CFO but it may also be used for other purposes.

Defendants claim that the patent itself limits the use of "null subcarrier" in the following phrase:

> In each OFDM transmission block, there are four non-zero training symbols, 4 zero symbols to remove interference from other channels, and one zero symbol serving as a null subcarrier.

('317 Patent at 155:63–67.) The Court is not persuaded that the above language limits the claim term in any way, nor does it overcome the plain and ordinary meaning of the term and the patentee's own explicit definition of the term. Even if this language limits

the use of a null subcarrier in this specification, limitations in a specification should not be imported into the claim construction. *Phillips*, 415 F.3d at 1320. The Court will, therefore, adopt the University's proposed construction of the term "null subcarrier" and decline to limit the use of "null subcarriers" to CFO only.

2. "Form . . . blocks of symbols/output symbols"/ "forming blocks of symbols/output symbols" ('317 Patent Claims 1 & 19; '185 Patent Claims 1, 9, & 18; '309 Patent Claims 1 & 13)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
Plain and ordinary meaning	Generating "blocks of symbols" for transmission at consecutive times.	Plain and ordinary meaning

Defendants' proposed construction includes two points of contention. First, the Defendants propose changing "form" to "generate." But Defendants provide no persuasive argument as to why generate is any clearer than form or why generate is necessary in the claim construction. *See Summit 6, LLC v. Samsung Elecs. Co.*, 802 F.3d 1283, 1291 (Fed. Cir. 2015) (stating that terms used in common parlance and have no special meaning need not be construed). As such, the Court sees no reason to include this phrase in the claim construction.

Second, Defendants seek to add the requirement that the blocks of symbols be formed at consecutive times. Defendants argue that the only specification dealing with the formation of blocks clearly states that the blocks are formed as "consecutive transmission blocks." ('317 Patent at 13:23–28.) Terms are to be given their ordinary and

plain meaning unless the terms are clearly defined in the patent, or the patentee has disavowed the full scope of the term. *Thorner*, 669 F.3d at 1366. Limitations in specifications are not read into claims. *Id.* The ordinary and plain meaning of the claim term does not require that the Court read in the limitation that blocks be formed at consecutive times, nor will the Court impose that limitation located in the specification into the claim construction.

Defendants contend that the claim needs such a limitation in order to be operable. When claim language permits an operable construction, the inoperable construction is wrong. *Ecolabs, Inc. v. FMC Corp.*, 569 F.3d 1335, 1345 (Fed. Cir. 2009). Defendants assert that if the block of symbols is not formed at a consecutive time, the system would be unable to measure the amount of data in a null subcarrier to estimate CFO. But Defendants focus solely on the use of the '317 Patent Family to estimate CFO. The '317 Patent Family also discusses techniques that can be used for channel estimation. ('317 Patent at 1:23–25 ("The invention relates to communication systems and, more particularly, carrier frequency offset estimation and channel estimation in communication systems.").)[8] Defendants have presented no persuasive reason to add this limitation into this claim term, the Court will not do so, and the Court will construe the term according to its plain and ordinary meaning.

[8] Defendants did not argue that channel estimation requires consecutive formation of blocks for transmission in order to be operable.

3. "Position(s)" (All asserted claims in '317, '185, & '309 Patents)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
The location of a symbol in a block of symbols	Frequency range	The location of a symbol in a block of symbols

All of the asserted claims in the '317 Patent Family use the term "position" and "positions" to refer to the location of a training symbol within the block of symbols. Defendants assert that this claim term should be construed to limit the term position to a specific frequency range (i.e. subcarrier). It is not disputed by the parties that the ordinary and plain meaning of "position" is not limited to frequency ranges. As such, the ordinary and plain meaning can only be disregarded when the patent provides a clear definition of the term or the patentee disavowed the broad scope of the term. *Thorner*, 669 F.3d at 1366.

Defendants claim that "position" should be limited for three reasons. First, Defendants point to the '317 Patent specification which discusses how the prior art placed training symbols in certain positions within a block, and that the prior art states that the positions within a block corresponded to a specific carrier frequency range. (*See* '317 Patent at 1:60–64; HIPERLAN/2 Specification.) But this discussion in the '317 Patent related to background information and nowhere in that section does the '317 Patent use

the term frequency in relation to position or claim that position is defined as a frequency range.

Second, Defendants point to the hopping code in the '317 Patent Family which is used to determine the position of training symbols and null subcarriers within each block. The hopping code is given by the formula Tsc(k) where "SC" stands for subcarrier. ('317 Patent at 8:10–24.) But limitations found in the specification of a claim cannot limit a claim term. *Phillips*, 415 F.3d at 1320. While true that the '317 Patent Family hopping code refers to placement of a training symbol or null subcarrier by looking to a subcarrier, such a limitation cannot be imported into the claim term to limit "position" absent clearer evidence within the patents that the patentee intended to limit the definition as such.

Lastly, Defendants point to a statement from a USPTO Examiner during the prosecution of a continuation application of the '317 Patent Family wherein the Examiner equated the "position" of a training symbol or null subcarrier with the subcarriers or frequency range. (Defs' Opening Markman Br., at 52.) But this statement alone cannot limit the claim term here. *Alfred E. Mann Found. For Sci. Res. V. Cochlear Corp.*, 841 F.3d 1334, 1341 (Fed. Cir. 2016) (holding that "an examiner's unilateral statement does not give rise to a clear disavowal of claim scope by the applicant."). And while prosecution history is relevant to the claim language, it "often lacks the clarity of the specification and thus is less useful for claim construction purposes." *Phillips*, 415 F.3d at 1317.

Defendants lack substantial evidence that supports their proposed limitation of the term "position." Nowhere in the '317 Patent Family is "position" defined as meaning the frequency range. Defendants have failed to present any persuasive argument that would convince the Court that it can deviate from the plain and ordinary meaning of the term. To be clear, adopting the University's construction does not mean that "position" cannot refer to the frequency range, it can, and therefore there is no issue with inoperability by adopting this construction. The Court will adopt the University's proposed construction of the term "position."

4. Block Length ('317 Patent Claims 1 & 19)

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
The number of symbols in a block	The number of subcarriers in a block of symbols	The number of symbols, including zero-symbols, in a block.

Two claims in the '317 Patent use a hopping code that employs block length in deciding where to position a null subcarrier in a block of symbols. The parties dispute whether block length is measured by the number of subcarriers in a block of symbols or the number of symbols in a block. The parties agree that a "block of symbols" is a "group of symbols." (Joint Claim Const. Stmt., at 3, Oct. 20, 2021, Docket No. 298.) The University argues that since a "block of symbols" means a "group of symbols" it follows that the "block length" is the "number of symbols in a block."

Defendants take issue with this syllogism because it fails to take into account the fact that a "block length" must account for symbols that carry data, and symbols that do not (i.e. zero-symbols). Defendants then assert that the claim term should be construed such that block length is defined by the number of subcarriers in a block of symbols. Defendants point to the specification to support their assertion. The '317 Patent states the following: "[t]he OFDM block length is designed as N = 64 as in HIPERLAN/2." ('317 Patent at 15:26–32.) HIPERLAN/2 defines block length, and "N", as the number of subcarriers. HIPERLAN/2 Standard (2001). Defendants, therefore, claim, that since block length is defined as "N" in the '317 Patent specification and "N" is defined as a subcarrier, the block length is the number of subcarriers.

But what this Court has repeated *ad naseum*, is that a specification cannot limit the claim term. *Thorner,* 669 F.3d at 1366. It is up to the patentee to set forth a clear definition of a disputed term in the patent, otherwise the term is given its plain and ordinary meaning. *Id.* at 1365. If a block of symbols is defined as a group of symbols, it would follow, absent contrary evidence, that a block length should be determined based on the number of symbols within it. But Defendants make a good point that such a conclusion fails to capture the important fact that the block length must take into account the zero-symbols because the purpose of a hopping code is to determine where the null subcarriers should be placed. If the hopping code looked at the block length to determine where a null subcarrier should be placed but did not take into account the fact that a zero-

symbol already existed in the block length, the hopping code, and thus the invention, would be rendered inoperable. There is an easy solution to this issue. The term block length must somehow incorporate the consideration of zero-symbols. Thus, the Court will construe "block length" to mean the following: The number of symbols, including zero-symbols, in a block.

5. "inserting at least one training symbol adjacent to at least one null subcarrier" ('185 Patent Claim 6; '309 Patent Claim 19)

a. "training symbol"

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
In a transmission system, a symbol having a predefined value that is transmitted by the transmitter to enable a receiver to determine a parameter that can be used to decode other transmitted symbols	a symbol with a predefined value that can be used by the device that receives the symbol to determine a physical characteristic of the transmitted signals	a symbol having a predefined value that is transmitted by the transmitter to enable a receiver to determine a parameter that can be used to decode other transmitted symbols

As an initial matter, the University has agreed to the removal of "in a transmission system" from their proposed construction of the claim term "training symbol" if the Court finds it unnecessary. (University's Opening Markman Br., at 39.) The Court sees no compelling reason to include that term, and will therefore, not include it in the claim construction.

The main dispute, then, is whether a "training symbol" allows a receiver to determine a parameter that can be used to decode other symbols or whether the

"training symbol" is used to determine a physical characteristic of the transmitted signals. Physical characteristics include things such as CFO, channel interference, channel estimation, and phase noise. (*See, e.g.* '317 Patent at 2:16–3:26.) Both parties agree that the "training symbols" ultimately assist in decoding.

The Court will adopt the University's proposed construction. First, contrary to Defendants' claim, the University's proposed use of the term "decode" does not require that a "training symbol" ultimately be used in decoding. Their construction states that the training symbols "can" be used to decode, not that they "must" be. It is also true that all training symbols are ways to help the receiver decode the transmitted symbols by analyzing physical characteristics such as CFO, channel estimation, and phase noise, to determine the ultimate transmission. So stating that the training symbols can be used in precoding is not contrary to the patent specifications.

Second, the Defendants' proposed construction is too broad. Expanding the definition of "training symbol" to any symbol that is used to determine a physical characteristic would sweep into the definition of "training symbol" any such symbol that has a predefined value. A symbol that has a predefined value but that is not used for training purposes would fall under the Defendants' proposed construction. To illustrate the breadth of Defendants' proposed construction, it is important to realize that a receiver must determine some physical characteristic of **all** symbols it receives.

The University's proposed construction is a more accurate construction of the claim term than Defendants. As such, the Court will construe the claim term "training symbol" as follows: a symbol having a predefined value that is transmitted by the transmitter to enable a receiver to determine a parameter that can be used to decode other transmitted symbols.

b. "Inserting at least one training symbol <u>adjacent</u> to at least one null subcarrier"

University's Proposed Construction	Defendants' Proposed Construction	Court's Construction
Placing at least one training symbol next to at least one null subcarrier	Inserting, within a block, at least one training symbol at an adjacent frequency to at least one null subcarrier	Placing at least one training symbol next to at least one null subcarrier

This issue centers on the construction of the term "adjacent." The University proposes the use of the ordinary and plain meaning of that term, construing the claim to mean that one training symbol must be "next to" one null subcarrier. The Defendants propose a construction that requires the training symbol be placed at an "adjacent frequency" to the null subcarrier.

The Defendants' arguments here are similar to the arguments raised in support of their proposed construction of the term "position." Defendants point to Figure 3 of the '317 Patent to show that the training symbol and null subcarrier must be placed at adjacent frequencies. But as discussed above, a specification cannot limit the ordinary and plain meaning of a claim term, and the '317 Patent Family language does not explicitly limit the claim term to frequencies.

While it may be true that the '317 Patent Family, in practice, often places a training symbol and null subcarrier at adjacent frequencies, this is not sufficient to adopt the limitation. It also seems to be that the training symbol and null subcarrier could be placed adjacent in time and that such placement would still be useful under the patent invention. Placing the training symbol and null subcarrier adjacent in time would not involve placing them at adjacent frequencies. Thus, the Court sees no compelling reason to limit the construction of the term "adjacent" to mean frequencies and will adopt the University's proposed construction which incorporates the ordinary and plain meaning of the term.

ORDER

Based on the foregoing, and all the files, records, and proceedings herein, the Court **ADOPTS** the construction of the claim terms and phrases within the '768, '230, '317, '185, and '309 patents as set forth in the Memorandum accompanying this Order.

DATED: August 5, 2022
at Minneapolis, Minnesota.

John R. Tunheim

JOHN R. TUNHEIM
United States District Judge